

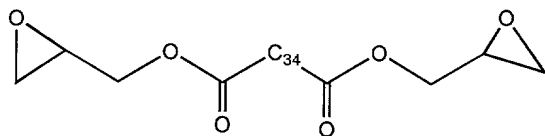
We claim:

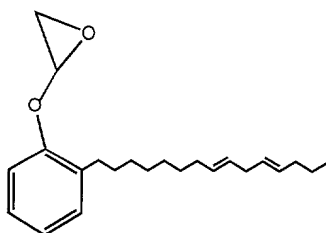
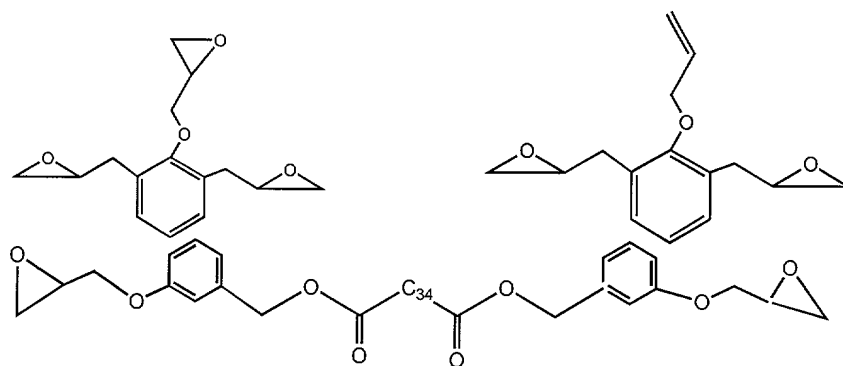
1. A B-stageable underfill encapsulant, wherein the encapsulant solidifies during the B-stage process to produce a smooth, non-tacky surface on a semiconductor wafer or silicon chip.

2. The B-stageable encapsulant of claim 1 comprising:

- a) a thermal curable resin;
- b) an imidazole-anhydride adduct;
- c) at least one solvent;
- d) one or more fluxing agents; and
- e) optionally, one or more the group comprising surfactants, wetting agents, defoaming agents, coupling agents, inorganic fillers, reactive diluents, adhesion promoters, flow additives, air release agents, and mixtures thereof.

3. The encapsulant of claim 2, wherein the at least one epoxy resin is selected from the group comprising monofunctional and multifunctional glycidyl ethers of Bisphenol-A, monofunctional and multifunctional glycidyl ethers of Bisphenol-F, aliphatic epoxies, aromatic epoxies, saturated epoxies, unsaturated epoxies, cycloaliphatic epoxy resins, epoxies having the structures





5 or mixtures thereof.

4. The encapsulant of claim 3, wherein the at least one epoxy resin is selected from the group consisting of 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate, vinylcyclohexene dioxide, 3,4-epoxy-6-methyl cyclohexyl methyl-3,4-epoxycyclohexane carboxylate, dicyclopentadiene dioxide, bisphenol A resin, bisphenol F type resin, epoxy novolac resin, poly(phenyl glycidyl ether)-co-formaldehyde, biphenyl type epoxy resin, dicyclopentadiene-phenol epoxy resins, naphthalene epoxy resins, epoxy functional butadiene acrylonitrile copolymers, epoxy functional polydimethyl siloxane, and mixtures thereof.

5. The encapsulant of claim 4, wherein the epoxy resin comprises in the range of about 20 wt % to about 90 wt % of the encapsulant.
- 5 6. The encapsulant of claim 5, wherein the at epoxy comprises in the range of about 20 wt % to about 80 wt % of the encapsulant.
7. The encapsulant of claim 1, wherein the imidazole-anhydride adduct comprise an adduct of imidazole and anhydride selected from the group
- 10 comprising pyromellitic dianhydride, methylhexa-hydro phthalic anhydride methyltetra-hydrophthalic anhydride, nadic methyl anhydride, hexa-hydro phthalic anhydride, tetra-hydro phthalic anhydride, dodecyl succinic anhydride, phthalic anhydride, bisphenyl dianhydride, benzophenone tetracarboxylic dianhydride, 1-cyanoethyl-2-ethyl-4-methyl-imidazole, alkyl-
- 15 substituted imidazole, triphenylphosphine, onium borate, non-N-substituted imidazoles, 1,2,4,5-benzenetetracarboxylic dianhydride, 2-phenyl-4-methyl imidazole, 2-ethyl-4-methyl-imidazole, 2-phenyl imidazole, imidazole, N-substituted imidazole and mixtures thereof.
- 20 8. The encapsulant of claim 7, wherein the imidazole-anhydride adduct comprises an adduct of 2-phenyl-4-methyl imidazole and pyrometillic dianhydride.
9. The encapsulant of claim 8, wherein the imidazole-anhydride adduct is
- 25 synthesized by combining 1 mole part 1,2,4,5-benzenetetracarboxylic dianhydride and 2 mole part 2-phenyl-4-methylimidazole.

10. The encapsulant of claim 7, wherein the imidazole-anhydride adduct comprises in the range of about 0.01 wt % to about 10 wt % of the encapsulant.
- 5 11. The encapsulant of claim 10, wherein the imidazole-anhydride adduct comprises in the range of about 0.1 wt % to about 5 wt % of the encapsulant.
12. The encapsulant of claim 2, wherein the at least one solvent is selected from the group comprising solvents that are stable and dissolve the epoxy
- 10 resins in the composition.
13. The encapsulant of claim 12, wherein the at least one solvent is selected from the group comprising ketones, esters, alcohols, ethers, γ -butyrolactone and propylene glycol methyl ethyl acetate (PGMEA) and mixtures thereof.
- 15 14. The encapsulant of claim 13, wherein the at least one solvent is selected from the group comprising γ -butyrolactone, propylene glycol methyl ethyl acetate (PGMEA) and mixtures thereof.
- 20 15. The encapsulant of claim 12, wherein the solvent comprises in up to about 80 wt % of the encapsulant.
16. The encapsulant of claim 2 further comprising at least one fluxing agent.
- 25 17. The encapsulant of claim 16 wherein the at least one fluxing agent is selected from the group comprising carboxylic acids, rosin gum, dodecanedioic acid, adipic acid, sebacic acid, polysebacic polyanhydride,

maleic acid, tartaric acid, citric acid, alcohols, hydroxyl acid and hydroxyl base, polyols such as ethylene glycol, glycerol, 3-[bis(glycidyl oxy methyl) methoxy]-1,2-propane diol, D-ribose, D-cellobiose, cellulose, 3-cyclohexene-1,1-dimethanol, and mixtures thereof.

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18. The encapsulant of claim 17, wherein the at least one flux agent comprises rosin gum, dodecanedioic acid, adipic acid, or mixtures thereof.

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19. The encapsulant of claim 18, wherein the at least one flux agent comprises in the range of about 0.5 wt % to about 20 wt % of the encapsulant.

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20. The encapsulant of claim 19, wherein the at least one flux agent comprises in the range of about 1 wt % to about 10 wt % of the encapsulant.

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21. The encapsulant of claim 2, wherein the encapsulant further comprises one or more of group consisting of surfactants, wetting agents, defoaming agents, coupling agents, inorganic fillers, reactive diluents, adhesion promoters, flow additives, air release agents, and mixtures thereof.

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22. The encapsulant of claim 21 wherein the surfactant is selected from the group consisting of organic acrylic polymers, silicones, epoxy-silicones, polyoxyethylene/polyoxypropylene block copolymers, ethylene diamine based polyoxyethylene/polyoxypropylene block copolymers, polyol-based polyoxyalkylenes, fatty alcohol-based polyoxyalkylenes, fatty alcohol polyoxyalkylene alkyl ethers and mixtures thereof.

23. The encapsulant of claim 22 wherein the reactant diluent is selected from the group comprising p-tert-butyl-phenyl-glycidyl ether, allyl glycidyl ether, glycerol diglycidyl ether, glycidyl ether of alkyl, butanedioldiglycidylether and mixtures thereof.

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24. The encapsulant of claim 2 wherein the underfill encapsulant is applied to a semiconductor wafer and B-stage processed before the semiconductor wafer is diced into individual chips.

10 25. A silicon wafer having a B-stageable underfill composition deposited on one face of the wafer, the B-stageable composition comprising

- a) a thermal curable resin;
- b) an imidazole-anhydride adduct;
- c) at least one solvent;
- d) one or more fluxing agents; and

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- e) optionally, one or more additive selected from the group

comprising surfactants, wetting agents, defoaming agents, coupling agents, inorganic fillers, reactive diluents, adhesion promoters, flow additives, air release agents, and mixtures thereof.

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26. A method of preparing one or more silicon chips, comprising the steps of

- a) applying the encapsulant of claim 2 to a semiconductor wafer;
- b) B-stage processing the encapsulant on the semiconductor wafer so that the encapsulant solidifies into a smooth, non-tacky coating; and

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- c) dicing the semiconductor wafer into individual silicon chips.

26. The method of claim 25, wherein the encapsulant is applied to the semiconductor wafer via spin coating, screen printing or stencil printing.

27. A method of preparing an electronic package comprising the steps of

- 5 a) applying the encapsulant of claim 2 to a semiconductor wafer;
- b) B-stage processing the encapsulant on the semiconductor wafer so that the encapsulant solidifies into a smooth, non-tacky coating;
- c) dicing the semiconductor wafer into multiple silicon chips, with each chip having a first side coated with the encapsulant;
- 10 d) placing one or more silicon chips on a substrate so that the first side of the silicon chip is adjacent to the substrate; and
- e) heating the one or more silicon chips and substrate to a temperature sufficient to form interconnections between the one or more silicon chips and the substrate.

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28. The method of claim 27, comprising the additional step of placing an unfilled liquid curable fluxing material on the substrate before the silicon chip is placed on the substrate.

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29. The method of claim 28, wherein the unfilled liquid curable fluxing material comprises

- a) a thermal curable epoxy resin;
- b) an imidazole-anhydride adduct; and
- c) at least one fluxing agent.

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30. The method of claim 29, wherein the imidazole-anhydride adduct comprise an adduct of imidazole and anhydride selected from the group

comprising pyromellitic dianhydride, methylhexa-hydro phthalic anhydride
methyltetra-hydrophthalic anhydride, nadic methyl anhydride, hexa-hydro
phthalic anhydride, tetra-hydro phthalic anhydride, dodecyl succinic
anhydride, phthalic anhydride, bisphenyl dianhydride, benzophenone

- 5 tetracarboxylic dianhydride, 1-cyanoethyl-2-ethyl-4-methyl-imidazole, alkyl-
substituted imidazole, triphenylphosphine, onium borate, non-N-substituted
imidazoles, 2-phenyl-4-methyl imidazole, 2-ethyl-4-methyl-imidazole, 2-
phenyl imidazole, imidazole, N-substituted imidazole and mixtures thereof.

- 10 31. The encapsulant of claim 30, wherein the imidazole-anhydride adduct
comprise an adduct of 2-phenyl-4-methyl imidazole and pyromellitic
dianhydride.